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Title: What is the value of wild animal welfare for restoration ecology?

Running head: Wild animal welfare

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Abstract

The restoration community continues to discuss what constitutes good environmental stewardship. One area of tension is the extent to which the wellbeing of wild animals should inform restoration efforts. We discuss three ways that the perspective of wild animal welfare can augment restoration ecology: strengthening people's relationship with nature, reinforcing biotic integrity, and reducing mechanistic uncertainty. The animal welfare movement elevates sentient animals as stakeholders and explores how environmental context directly impacts the wellbeing of individuals. Viewing wild animals through this lens may encourage people to think and act

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with empathy and altruism. Second, we incorporate animal welfare into the concept of biotic integrity for ecological and ethical reasons. Restoring ecosystem processes may enhance animal welfare, and vice versa. Alternatively, there may be a trade-off between these factors, requiring local decision-makers to prioritize between restoring ecosystem function and promoting individuals' wellbeing. We conclude by discussing how welfare can impact population recovery, thereby adding insights about mechanisms underpinning restoration objectives. Ultimately, restoration ecologists and proponents of wild animal welfare could enjoy a productive union.

Keywords: biotic integrity, ecosystem health, environmental stewardship, land ethic, rewilding

Conceptual implications

- The perspective of wild animal welfare may deepen people's relationship with nature by cultivating empathy and altruism.
- Biotic integrity has both ecological and ethical components. There may be opportunities to reinforce biotic integrity in multidimensional ways, such as when enhancing wild animal welfare concomitantly restores ecosystem processes.
- Factors relevant to welfare, particularly physiology, behavior, and cognition, can impact the recovery of animal populations and communities.

Introduction

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Restoration ecology has long been guided by ethics. The renowned conservationist Aldo Leopold (1966) wrote the land ethic, which "*enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land… a land ethic changes the role of* Homo sapiens *from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members, and also respect for the community as such... A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community."* These statements shifted how nonhuman lifeforms were valued, placing them in a collective pact with humans and emphasizing how ecosystem function supports the biotic-community members (Callicott 2013).

Despite the value placed on animals in the land ethic ("fellow-members"), practitioners of environmental management have not resolved how to support the wellbeing of individuals while also maintaining the integrity of the ecosystem (Swaisgood 2010; Lorimer et al. 2015; but see Dubois et al. 2017). Another challenge is the growing call for restoration to integrate with a broader suite of environmental issues and disciplines (Miller & Bestelmeyer 2016; Beausoleil et al. 2018), while also increasing the effectiveness of the projects under its auspices (Brudvig et al. 2017). To address these problems, we examine theories and case studies which illustrate the value of wild animal welfare for reducing uncertainty during ecological restoration, conceptualizing and restoring biotic integrity, and strengthening human-nature relationships.

Engagement through the lens of wild animal welfare

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Supporters of animal welfare, similarly to Leopold, want to expand society's moral circle to encompass more than humans' self-interest (Singer 2001; Callicott 2013). To achieve this goal, the animal welfare movement elevates animals as stakeholders. Some animal welfare advocates use the framework of utilitarianism, a moral philosophy that calls on society to reduce the suffering of individuals as much as possible. They extend the principle of equal consideration of interests beyond humans to consider the interests of all "sentient beings"—defined as humans and animals with the ability to have subjective, positive or negative experiences (Singer 2001; but see Rose et al. 2012 for criticism). The enormous number of wild animals makes wildlife a compelling focus for supporters of animal welfare who seek to maximize their impact.

Many members of the animal welfare community use scientific research to make evidence-based improvements to animals' lives (Dawkins 2006). The dominant method for assessing animal welfare is the Five Domains model. It measures an animal's nutrition, environment, health, and behavior, and uses this information to infer their affect (i.e., subjective experiences such as hunger, security, etc.). The five domains are then reviewed to understand how the individual is functioning and feeling in relation to its environmental context (Mellor & Beausoleil 2015). It is worth noting that traditional ecological knowledge has viewed animals "on their own terms" for thousands of years, whereas considering animals as subjects is relatively new to Western science (Pierotti & Wildcat 2000).

To practically improve the welfare of wild animals, several ethical and ecological conundrums still need to be reconciled (e.g. Singer 2001; Driscoll & Watson 2019). Meanwhile,

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animal welfare and environmental management can foster an amicable relationship. In conservation medicine, for example, wildlife health is accepted as a driver and indicator of ecosystem health and the pragmatism of supporting animal health dovetails with its moral value (Zinsstag et al. 2011; Keeleyside et al. 2012).

The same collaborative dynamic between restoration ecology and wild animal welfare could be built around the shared goal of strengthening people's relationship with nature (Seddon & Van Heezik 2013). Discussing wild animal welfare illustrates tangible impacts that the environment has on individuals. This lens ideally strengthens the role of humans as environmental stewards by encouraging people to empathize with animals and act to give them better lives (Ramp & Bekoff 2005). People, when challenged on a moral level, may be willing to forgo aesthetic or economic benefits to enhance animal wellbeing (Doak et al. 2014; Coon et al. 2018).

Reinforce biotic integrity along both ethical and ecological dimensions

The consideration of wild animal welfare also has implications for conceptualizing and restoring biotic integrity. The first ecological assessment of biotic integrity surveyed fish community composition with reference to sex-age cohorts, body condition, and trophic structures as indicators of riverine ecosystem health (Karr 1981). Currently, the Society for Ecological Restoration defines ecosystem integrity as "the ability of an ecosystem to support and sustain characteristic ecological functioning and biodiversity (i.e., species composition and community structure)" (Gann et al. 2019). In addition to ecological components, however, biotic integrity

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has ethical dimensions related to the treatment of nonhuman individuals, according to the precedent established in Leopold's land ethic.

The support of animal wellbeing provides opportunities to address both components of biotic integrity (Zinsstag et al. 2011). For example, restoration efforts increasingly aim to resume ecosystem processes by reintroducing animals with roles as consumers or ecosystem engineers (Pettorelli et al. 2018). Stress can cause negative behavioral and physiological reactions, such as immune responses, which compromise survival, reproductive fitness, and performance of keystone behaviors. Stress can also result in poor welfare (Broom & Johnson 1993; Blumstein 2010; Tarszisz et al. 2014). Therefore, reducing stress in animals that facilitate ecosystem processes may lead to concurrent improvements to ecosystem functioning and animal welfare. In other contexts, these two targets may be distinct objectives and their prioritization will vary depending on stakeholders' values (Lorimer et al. 2015; Beausoleil et al. 2018). Even if the conflict between supporting ecosystems or individuals cannot be entirely resolved, the deliberation itself illustrates the ecological and moral consequences of human decisions on the nonhuman members of the biotic community.

When individual wellbeing and ecosystem health are entwined, the divide between wild animal welfare and restoration ecology should shrink (Swaisgood 2010). Interdisciplinary projects could aim to provide relief from stressors, including, but not limited to, human-caused degradation. The scale and severity of impacts on animal welfare could be estimated by evaluating the number of animals affected, cause and duration of the harm, and the capacity of

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animals to suffer (Kirkwood et al. 1994; Dubois et al. 2017). One metric for evaluating a restored area could be the quality of life the site provides to humans and animals, especially in areas with no historical analogue or reference baselines. These approaches create common ground to address contemporary environmental problems by bridging the perceived dichotomy between supporting wild animal welfare and functioning ecosystems.

Reduce mechanistic uncertainty by focusing on individuals

In practice, restoration outcomes are largely uncertain (Brudvig et al. 2017). Many efforts fail to recover animal populations after the vegetation and physical environment are restored, due to insufficient knowledge regarding whether these areas provide focal taxa with adequate resources. What is "adequate" depends upon the animals' tolerances, adaptive abilities, and perceived opportunities to exploit these resources (Simenstad & Cordell 2000; Jones & Davidson 2016). Particularly in the context of animal restorations, attention to individual-level processes, such as physiology, behavior, and cognition, can be used to predict restoration outcomes or meet other key objectives (Cooke & Suski 2008; McKenzie et al. 2016).

This integration is applicable to projects that target population recovery, as demographic rates often depend on an individual's sex, age, organismal performance, perceived social rank, exposure to stressors, or combinations of these characteristics. Thus, breaking analyses down into finer cohorts more accurately predicts population structure and growth (Gerber & Heppell 2004; Caswell et al. 2018). A focus on welfare can further reveal nuanced drivers of population

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change. For example, vulnerability to mortality in albatrosses (Diomedea exulans) was shown to decrease with age (until senescence) because juveniles were less competent at foraging and navigating than adults. The difference in vulnerability between age cohorts explained the recovery projections for this population (Riotte-Lambert & Weimerskirch 2013). Furthermore, foraging and navigating performance depended on early-life experiences formed through learning, in addition to environmental context (Fay et al. 2018), illustrating how animals' mental, physical, and functional states interrelate (Beausoleil et al. 2018; Cordiero et al. 2018; Louison et al. 2019). The use of animals' activities and experiences to understand patterns at population, community, or ecosystem levels continues to grow in the context of management, reflecting the benefits of focusing on individuals to reduce mechanistic uncertainty.

Conclusions

Several aspects of animal welfare, such as health, physiology, behavior, and cognition, are processes that can modify the patterns of species, communities, and ecosystems. We can therefore reduce uncertainty regarding the mechanisms underpinning restoration objectives by increasing our understanding of individuals. There is the potential for optimal outcomes when improvements to ecosystem function and individual wellbeing reinforce each other. These synergies may enhance biotic integrity in multidimensional ways, by supporting two levels of biotic organization and encompassing multiple ethical stances regarding what is good stewardship. Finally, restoration ecology could engage with the perspective of animal welfare to

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advance a human-nature relationship that is infused with empathy and altruism. Proponents of wild animal welfare and the land ethic already agree that humans and animals are part of one biotic community with a common stake in environmental decision-making.

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